Word-reading and word-spelling styles of French beginners: Do all children learn to read and spell in the same way?

(footnote)

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Abstract

This article explores the styles of word reading and word spelling used by beginning readers in the French language. The aim of the study was to find out whether "sub-lexical" and "lexical" styles of reliance, which has been observed in children learning to read and spell in English, exists in French, a language with a more transparent orthography. A sample of 159 subjects were assessed on their reading and spelling of regular words, irregular words and nonwords. Cluster analyses on reading/spelling performances led us to identify various profiles, among which sub-lexical and lexical styles could be discerned. These profiles were then compared across a set of linguistic tasks in order to look for factors that might be related to individual differences in reading/spelling styles. Overall, our findings suggest that quantitative level differences explain most individual variation in literacy. These results are discussed in relation to developmental models of reading and spelling in different orthographic systems.

Key words : reading development, spelling, individual differences, French orthography, lexical and sub-lexical strategies

A central issue in the study of individual differences in reading concerns the way in which children learn to recognize words and the type of difficulties they encounter. On a theoretical level, this issue casts doubt on the validity of general models of acquisition, according to which learning to read involves two successive stages: the acquisition of the alphabetic principle and the storage of orthographic representations. Do all children acquire reading ability in the same way, differing only in speed and accuracy? Or are there different routes of acquisition, meaning that, at a given point in their schooling, children will preferentially use different reading procedures? On a practical level, at a time when education professionals are worrying about the high number of poor readers at the end of elementary school, it is important to know whether word identification difficulties in the early stages of learning are homogeneous.

In this study we had two aims. First, among a broad sample of 2nd-graders, we set out to examine both quantitative and qualitative differences in the alphabetic and orthographic processing of words in reading and spelling in French. Some qualitative differences between readers, called "*sub-lexical*" and "*lexical*" respectively, have been found in English but not in other languages. Second, we explored how these differences were related to other linguistic skills, notably metaphonological abilities and text comprehension.

Reading and spelling acquisition in a general developmental framework

Traditional models of literacy acquisition depict reading development as a sequence of stages. Of these, Frith's model (1985) is interesting, because it provides a theoretical framework within which spelling and reading interact, increasing the learner's proficiency in each ability. The first stage is referred to as "logographic": children read by using visual partial cues but are largely unable to

write more than a few whole words from memory, as spelling requires full cues. In the second stage, the need to write transforms the children's approach to print. Children start to spell by establishing correspondences between sounds (phonemes) and letters (graphemes), and this signals entry to the "alphabetic" phase of development. Their awareness of the relationships between graphemes and phonemes (*sub-lexical units*) is then applied to the reading process and gradually enables them to use phonological decoding for any new written word they encounter. In the third stage, children move into the "orthographic phase", when reading and spelling are independent of sound. This transition first occurs in reading. On the basis of the extensive analysis of letter sequences in words, children develop a whole-word (*lexical*) recognition process. Orthographic representations acquired through reading are then transferred to spelling. [Note that the alphabetic and orthographic stages parallels the distinction between sub-lexical and lexical procedures in dual-route models of expert reading, except that the latter are rapid and automatic (Coltheart, 1978; Coltheart, Curtis, Atkins, & Haller, 1993.]

In this framework, a central question is whether phonological decoding and the orthographic process develop and function independently of each other or alternately. Studies showing poor readers' difficulties specifically in the use of orthographic processing are compatible with stage models (Ehri & Saltmarsh, 1995; Reitsma, 1983). For example, poor readers need more attempts at learning new irregular words than good readers, though this is not the case for pseudo-homophones, suggesting that poor readers rely mainly on grapheme-phoneme conversion (GPC) rules due to difficulties in attaining the orthographic stage. Other studies, on the contrary, suggest that phonological decoding is mainly

affected in poor readers, who actually display a high level of orthographic knowledge when it comes to determining which of two nonwords could be a real word (one of them containing an impossible bigram, e.g., *filv vs. filk*; Siegel, Share & Geva, 1995).These contrasting findings allow us to assume that there must be individual qualitative differences in word identification, which correspond to different styles of acquisition, matched by the emergence of different types of problems (Rieben, Saada-Robert & Moro, 1997).

How do individual differences affect reading?

Inter-individual differences in word-reading strategies were first highlighted in correlational studies carried out by Baron (1979) and Treiman (1984). In their experiments, nonword reading performance (N) was used as an indicator to reflect children's ability to apply GPC rules, whereas the scores on irregular word reading (I) assessed their word-specific knowledge. The authors found that the correlation between nonword and irregular word reading (rNI) was lower than the correlations between nonword and regular word reading (rNR) on the one hand, and irregular and regular word reading (rIR) on the other. This was interpreted as reflecting differences among children in their dominant reliance on either phonological decoding or orthographic processing.

Freebody and Byrne (1988) and Byrne, Freebody and Gates (1992) replicated these patterns of correlation with 2nd- to 4th-grade children, who had to pronounce three lists of items, and confirmed the existence of two styles of word reading. In actual fact, their cluster analysis of irregular and nonword reading scores revealed the existence of two subgroups of subjects whose performances contrasted with those of good and poor readers. One set, referred to as "Phoenicians", performed better on their reading of nonwords compared with

irregular words, demonstrating normal acquisition of phonological decoding but specific difficulty in recognizing words as entire orthographic units. The other set, referred to as "Chinese" readers, displayed the opposite pattern, having specific difficulty in nonword reading, which suggested that they relied heavily on orthographic processing. The groups differed also in that "Chinese" readers showed a progressive deterioration in word reading from 2nd- to 4th-grade, while the reading scores of the "Phoenicians" improved. This distinction between "Phoenicians" (now known as "sub-lexical" readers) and "Chinese" (now known as "lexical" readers) in the normal range of reading performance parallels to some extent the classification of developmental dyslexics, which differentiates between surface and phonological dyslexia (Castles & Coltheart, 1993; Manis, Seidenberg, Doi, McBride-Chang & Petersen, 1996; Stanovich, Siegel, & Gottardo, 1997; Valdois, 2000). Recent hypotheses suggest that phonological dyslexia is associated with phonological awareness deficit**,** whereas surface dyslexia could be due to major difficulties in visual tasks (Goulandris & Snowling, 1991; Valdois, 1996).

Relations between word identification styles and spelling

Some authors have asked whether it is possible to discern lexical and sub-lexical styles in spelling, with the former involving direct access to an orthographic output lexicon, the latter conversion of phonological information into a graphemic code (Lennox & Siegel, 1996; Weekes, 1994). Using the same reasoning as for reading, Treiman (1984) found that the spelling of nonwords by 3rd- and 4th-grade students correlated with their spelling of regular words, as well as with the rate of phonological errors (spelling mistakes which obey the phoneme-grapheme conversion, or PGC, rules), but far less so with the spelling of irregular words. Weekes (1994) showed that "lexical" and "sub-lexical" adult readers,

identified on the basis of correct spelling choices and homophony decisions, were equally efficient in spelling nonwords and regular words, but lexical readers spelled irregular words and homophones more accurately. Lastly, Castles, Holmes and Wong (1997) provided evidence of a relationship between word identification styles and spelling in 3rd-grade students. They identified three groups of children matched on lexical age but with contrasting profiles in irregular word reading and nonword reading. While the groups did not differ in word spelling, the sub-lexical readers were much better at spelling nonwords and made more regularization errors than the lexical readers, who conversely produced more lexicalizations.

Taken together, these results lend further weight to the hypothesis of a functional independence of lexical and sub-lexical processes. However, the relationships between reading profiles and spelling scores do not directly demonstrate the existence of different spelling styles. Accordingly**,** following the reasoning of Freebody and Byrne (1988) for reading, the present study sought to test more directly the possibility of identifying distinct spelling groups by examining the children's relative reliance on conversion rules versus word-specific knowledge in both reading *and* spelling.

Characteristics of orthography and reading acquisition

The distinction between lexical and sub-lexical readers was first established for English orthography. Orthographies can be placed on a continuum between transparent orthographies with consistent grapheme-phoneme mappings as in Italian, Spanish, German and, to some extent, French (see below), and deep orthographies where, depending on its context, the same letter can represent different phonemes and the same phoneme can be represented by different letters, as in English (Frost, Katz & Bentin, 1987). The impact of orthographic depth on

general tendencies in the reading acquisition process is now being illustrated by a growing number of studies (Frost & Katz, 1992; Müller & Brady, 2001). A new, related question addressed by the present study is whether individual qualitative differences in lexical and sub-lexical processes can be observed in a more transparent language than English, at least for GPC rules (see below).

Comparative studies have, for example, shown that the problems most frequently encountered by poor or young readers in English are different from those encountered in German (Wimmer, 1996; Wimmer & Goswami, 1994). English beginners produce far more errors, consisting mainly in nonresponses or substitutions of one word for another. The depth of English orthography may require greater reliance on the lexical process, the efficiency of which is thus a major source of individual differences (whereas German learners essentially vary on reading times). In the same way, word length affects reading performance in Italian (Cossu, Gugliotta & Marshall, 1995) as well as in Spanish, but not in English (Goswami, Gombert & Fraca de Barrera, 1998). Conversely, performance is facilitated by lexicality in English more than it is in French and Spanish. This leads us to suppose that orthographic features constitute a less *informative* cue when GPC rules are more consistent. Consequently, in more transparent orthographies, much of the variation may be explained by phonological processing.

Although general tendencies have been compared across languages, few studies have analyzed inter-individual variations in languages other than English. An English-Portuguese study examining reading profiles in 4th-grade children (Pinheiro, 1999) found that while *all* English-speaking readers read frequent words better, the frequency effect was only significant for half the Brazilian readers. The

author interpreted these results by the fact that unlike English, most irregular words in Portuguese can be pronounced following the GP conversion rules. Similarly, all the Scottish participants, but only two Brazilians, had more difficulties with irregular words. The author argued that many words classified as irregular in Portuguese may only be irregular from the point of view of spelling, or are rule-based, and can be pronounced following the GPC rules. All things considered, individual variations were not the same in both languages.

Characteristics of French orthography

A critical aspect of the French written system is that the PGC rules used in spelling are far less consistent than GPC rules used to read words (Ziegler, Jacobs & Stone, 1996). It follows that using GPC rules makes it possible to read approximately 90% of French words correctly, whereas using PGC rules only makes it possible to spell half of all French words (Véronis, 1988). In other words, French orthography is more consistent than English orthography only as far as spelling-to-sound is concerned.

The acquisition of reading in French orthography has been mainly investigated by Sprenger-Charolles, Siegel & Bonnet (1998)**,** who have established that students primarily rely on phonological decoding in the first stage of reading and spelling. Their study revealed the emergence of the mean effects of frequency (for both tasks) and lexicality (for reading) between the beginning and the end of 1st grade, accompanied by a decrease in the mean regularity effects. In addition, phonological decoding in January correlated with irregular word reading in June, although the reverse was not true, supporting the idea that it is the phonological process that allows the establishment of the orthographic lexicon. Leybaert and Content (1995) reached a similar conclusion when they examined reading and

spelling in 2nd- to 6th-graders. Their results further indicated that development in groups taught using an alphabetic method (that promotes the sub-lexical process) and groups taught using a whole-word method (that promotes the lexical process) proceeds in a very similar fashion. Thus, irrespective of the teaching method, the acquisition of the sub-lexical process seems to constitute a necessary step in the acquisition of reading and spelling ability in French. Lastly, a comparison of reading acquisition in French and English (Bruck, Genesee & Caravolas, 1997) showed that the phonological awareness task which best predicted reading progress differed in the two languages, and 1st-grade French students were far better at reading than their English-speaking counterparts, especially with nonwords. No spelling task was included in this study.

To conclude, reading acquisition in French would appear to rely on different mechanisms and to be affected by different sources of variation than in English. However, until now, French research has not looked at individual differences, focusing instead on mean performances averaged over subjects in whole samples or instruction groups. The only published French studies to have reported individual differences in reading profiles have concerned dyslexic children (Génard, Alegria & Mousty, 1999; Sprenger-Charolles, Colé, Lacert & Serniclaes, 2000). In these experiments, on the basis of nonword and irregular word reading scores, the authors identified far fewer cases of phonological dyslexia than of surface dyslexia, whereas the proportions are almost equal in English studies (Castles & Coltheart, 1993; Manis et al., 1996). One interpretation is that the consistency of GPC rules in French gives the phonological process a major role to play. If this is impaired, it hinders the development of orthographic processing to a greater or lesser extent, depending on the degree of deficit. If it

functions normally, it allows the orthographic process to develop efficiently. Nevertheless, in the normal range of reading ability, we do not know whether different students may present various profiles reflecting different styles (and not only speed and accuracy differences) in learning to read and spell in the French system, as has been observed in English.

The aims of the study

The main aim of our study was to test the existence of "lexical" and "sub-lexical" styles in French, for reading as well as for spelling. Since word reading and word spelling are likely to be achieved either by using a lexical process or by applying conversion rules, we could hypothesize, on the basis of English-language studies (Byrne et al., 1992; Castles et al., 1997), that children would vary in their dominant reliance on one or other of these processes. On the other hand, the characteristics of French orthography**,** compared with English**,** might lead us to expect divergent results in reading and spelling. Given the consistency of the GP system in French, the establishment of phonological decoding might initially be necessary and indeed sufficient to learn to identify written words. As a result, children experiencing difficulties in reading would mainly be those who do not apply the GPC rules correctly. Conversely, insofar as the PGC rules are extremely inconsistent, we could expect more qualitative differences in spelling, with the emergence of lexical and sub-lexical profiles.

Following the reasoning of Freebody and Byrne (1988) and Byrne et al. (1992), our experimental procedure consisted in asking 2nd-graders to read and spell regular words, irregular words and nonwords. Irregular word processing and nonword processing assessed the efficiency of the orthographic and phonological processes respectively, in order to identify individual profiles reflecting different

styles of acquisition. The children also performed a set of linguistic tasks, to find out whether profiles were associated with specific cognitive factors and had implications for reading speed and comprehension. An initial study (Eme, Percheron & Golder, 1999) found that qualitative differences in word identification might be partly linked to the individuals' phonological awareness and visual memory abilities.

Method

Participants

One-hundred-fifty-nine 2nd-graders attending state schools in Poitiers and the surrounding area (Western France) took part in the experiment between February and March. By this time, the pupils had been learning to read for 18 months, so a wide range of word identification levels was represented. All the children (69 girls and 90 boys, mean age 7 years 7 months, range 10 months) came from the middle socioeconomic class and were native French-speakers. They were receiving normal schooling, none having repeated their first year and none having any known psychological, intellectual or emotional problems. In preliminary interviews, the teachers stated that they used combined methods for teaching them to read, including systematic exercises on the alphabetic code and a more whole-language approach based on the meaning of words and messages.

Tasks and materials

The children underwent a battery of tasks, consisting of the reading and spelling of isolated words and nonwords, an in-context reading task, a written comprehension test and an assessment of their metaphonological abilities. The methodology of each of these measurements is described below**,** with examples of the materials.

The isolated word reading task. Three lists of items were drawn up, comprising 40 regular words, 40 irregular words and 40 nonwords respectively. Based on the classification put forward by Catach (1980) and used by Sprenger-Charolles et al. (1998), a word was defined as regular if it only contained frequent grapheme-phoneme relations, and a word was defined as irregular if it contained either a highly infrequent grapheme, which could not be converted into a phoneme using the normal conversion rules (such as the *e* pronounced [a] instead of [ɛ] in *femme* [fam] (*woman*)), or a silent grapheme that was not in the final position (like the *p* in *sept* [sɛt] (*seven*)). The regular and irregular words were matched according to length (number of letters, number of graphemes and number of syllables) and frequency. Each list comprised 20 frequent words and 20 non-frequent or rare words, selected from the BRULEX lexical frequency database (Content, Mousty & Radeau, 1990) and judged by the teachers to be known to the pupils. For each level of frequency, half the words were mono- or bisyllabic, comprising three to five letters, while the other half were multi-syllabic words of six to nine letters. It should be noted that controls for building the irregular list were necessarily limited, due to the relatively low frequency of GP irregularities in French. For example, frequent and rare irregular words were not matched for position or type of irregularity. Nonwords only contained graphemes that are common in French and were matched in orthography and length with real words (*soir* gave the nonword *doil*; *jambon* the nonword *jaudon*, etc., Appendix 1).

Each item was displayed in the center of a card, printed in lower-case letters (font: 14). The participants were asked to read the three lists of items aloud, starting with the regular, then the irregular words, and always in the same order (short frequent – long frequent – short rare – long rare), so that the level of

difficulty would gradually increase. Last, they read the corresponding nonwords. We counted a correct response each time the subject pronounced the word correctly, without hesitation (pausing during the word, stumbling, etc.), repetition or deviation.

The isolated word spelling task. The three lists of 40 items were dictated alternately to the participants, who had to write the items on three separate sheets. To avoid any confusion with homophones and any phonological confusion, the words were read out within the context of a sentence and were repeated twice. We used the same coding that Treiman (1984) and Sprenger-Charolles et al. (1998) used in their studies. A correct response was counted each time the words were correctly spelled. For the nonwords, a response was deemed to be correct when the spelling obeyed the PGC rules of French (for example, *bir* [b i r] can be spelled *bir*, *bire*, *birre, bird*, etc.). This method made the word spelling scoring more demanding, but allowed us to test the lexicality effect on spelling and reading in the same way, in order to compare the two skills.

The phonological awareness task. The children's phonological awareness was assessed by means of a task involving the explicit manipulation of phonemes. The task was inspired by the Battery for Assessing Written Language (BELEC; Mousty, Leybaert, Alegria, Content & Morais, 1994) and consisted of two parts: phoneme substraction ("If you take the first sound away from *fontaine* (or from *planète*) what do you get?"; 14 items) and phoneme inversion ("If you reverse the sounds of *ile* [i l] (or *four* [f u r]) what do you get?"; 10 items). Previous research on phonological awareness had shown that phoneme analysis and synthesis tasks were still discriminative at 2nd grade and closely linked to differences in reading

levels (Stanovich, Cunningham & Cramer, 1984; Wagner, Torgesen, Rashotte, Hecht, Barker, Burgess et al., 1997).

The written comprehension test. The materials were taken from the Silent Reading Test (Aubret & Blanchard, 1991), which is designed to measure reading comprehension in 8 to 15 year-olds. For our sample, we used four of the short, narrative texts of increasing difficulty ("Fannoux", "Colin", "Michèle et Caroline", "Paul"), each of which was followed by six questions about different aspects of comprehension (vocabulary, inferences, co-reference, etc., Appendix 2). The children were given 30 minutes to read the texts silently and write their answers on test sheets. Each response was scored out of two. The maximum total score was 48.

The in-context reading task. The identification of written words in context was assessed by means of a text containing many difficulties in phonological decoding (complex words, phonologically similar words, etc.; "Jeannot et Georges" Test, Text 1, Hermabessière & Sax, 1972, Appendix 3). Children were instructed to adopt a normal reading pace in order to be able to tell the story. The reading times and the number of errors were computed for each child, as indicators of his or her efficiency in phonologically decoding words in a natural reading situation.

Procedure

Each subject was seen for three experimental sessions, lasting 30 minutes each. The first session was individual and included the isolated word reading task, the metaphonological task and the in-context reading task. The reading tasks were recorded, then transcribed and coded by two independent assessors. The assessors initially agreed on 93% of the results for the isolated word reading and 97% for the in-context word reading. All the disagreements were settled after discussion. Two

or three weeks later, the children were seen collectively, in groups of between six and ten subjects. They took the comprehension test in the first half of the morning (except for one absent subject) and the word dictation test in the second half (except for two absent subjects).

Results

Several analyses were made of the data. The first analysis involved the mean scores in reading and spelling for the sample as a whole. The objective was to find out whether the results of previous studies regarding general tendencies of literacy acquisition (Leybaert & Content, 1995; Sprenger-Charolles et al., 1998) could be replicated with a larger sample. The second and third analyses were carried out on individual data, in reading and spelling respectively, in order to highlight different profiles and examine their relations to other linguistic skills. Given the nature of French orthography, we expected the correlation between phonological and orthographic procedures, as measured by nonword and irregular word processing, to be stronger in reading than in spelling, providing more contrasting profiles in spelling. A fourth analysis explored the link between reading profiles and spelling profiles.

Analysis 1: Overall results in the reading and spelling of isolated words

Table 1 shows the mean percentages of correct responses for the reading task (top) and spelling task (bottom) according to word category. Two series of ANOVAs were conducted on the reading and spelling data respectively, in order to examine lexicality and regularity effects as indicators of the acquisition of phonological and orthographic processes.

In reading, the first ANOVA on the factors regularity (regular and irregular words), frequency (frequent and rare words) and length (short and long words)

showed that all three main effects were significant. Children read regular words better than irregular ones ($F(1,158)=1263.51$, $p<.001$, $d=2.819$), and frequent words better than rare ones ($F(1,158)=408.75$, $p<.001$, $d=1.603$). The frequency x regularity interaction was also significant ($F(1,158)=73.33$, $p<.001$), indicating that frequency improves reading, especially for words that cannot be read using GPC rules ($d=1.428$ for irregular words, $d=0.664$ for regular words). The length effect interacted with regularity ($F(1,158)=47.71$, $p<.001$): partial comparisons showed that it was not significant for regular words, ($F<1$, $d=0.021$), whereas long irregular words were better read than short ones, though only when they were rare ($F<1$, $d=0.042$ for frequent irregular words; $F(1,158)=121.99$, $p<.001$, $d=-0.876$ for rare irregular words). This interaction can be explained by the fact that the longer the irregular word, the longer the regular part of the word, and the smaller the disturbance due to irregularity.

The second ANOVA on the factors lexicality (regular words vs. nonwords) and length showed that the real words were read significantly better than the nonwords ($F(1,158)=228.16$, $p<.001$, $d=1.198$). The length effect interacted with lexicality ($F(1,158)=32.18$, $p<.001$), indicating that length only hindered the reading of nonwords ($F(1,158)=40.27$, $p.<001$, $d=0.503$), thereby confirming that the GPC rules were involved to a greater extent.

Insert table 1 about here

In spelling, mean percentages of correct responses were lower (46% vs. 73% in reading), but strongly correlated with reading scores (median correlation $r=.65$) and were similarly influenced by effects of word category.

The first ANOVA was conducted on regularity x frequency x length, and revealed that regular words were spelled significantly better than irregular ones ($F(1,156)=1277.79$, $p<.001$, $d=2.853$) and frequent words were spelled significantly better than rare ones ($F(1,156)=338.46$, $p<.001$, $d=1.468$). The length x regularity interaction was significant, the length effect being significant for irregular words ($F(1,156)=387.71$, $p<.001$, $d=1.571$) but not for regular words ($F<1$). The three-way interaction arose ($F(1,156)=173.67$, $p<.001$) because regular word spelling decreased slightly only with frequency, whereas irregular words were far better spelled when frequent and short.

The second ANOVA showed an interaction between lexicality and length ($F(1,156)=88.73$, $p<.001$). For long items, the real words were spelled better than the nonwords ($F(1,156)=25.69$, $p<.001$, $d=0.405$), whereas for short items, the nonwords were spelled slightly better than the real words ($F(1,156)=13.24$, $p<.001$, $d=-0.290$). One explanation is that the more spelling involved the PGC rules, the more length hindered spelling.

In short, this first mean analysis highlighted a broad effect of word regularity and frequency in reading and an interaction between these two factors, without any notable effect of length (at least for regular words), as well as a lexicality effect. These findings replicated general tendencies noted in previous studies, in particular those observed in French children at the end of their first year of elementary school by Sprenger-Charolles et al. (1998). Similarly, the results can be interpreted as evidence of the construction of orthographic representations (effect of frequency and lexicality), though with continuing recourse to phonological decoding (effect of regularity). However, these ambivalent results might also reflect the fact that certain subjects had recourse mainly to orthographic

processing, while others resorted more to phonological decoding. Moreover, in the spelling tasks, we noted an effect of lexicality, which also points to the role of lexical knowledge at this level.

Analysis 2: Individual differences in the reading of isolated words

Analysis of correlations. In order to highlight individual differences in the dominant reliance on either phonological decoding or orthographic processing, we worked out the correlations between the performances in reading regular words (R), irregular words (I) and nonwords (N). N scores were assumed to reflect the child's ability to use rules, whereas I scores reflected reliance on word-specific knowledge. R scores might reflect some combination of conversion rules and lexical knowledge, since both processes aid performance (Treiman, 1984). If the correlation between irregular word reading and nonword reading (rIN) turned out to be weaker than the two others (rIR and rRN), it would mean that phonological decoding and the orthographic process function relatively independently.

In fact all three tasks were highly and significantly correlated ($p<.001$; Table 2). The correlation between irregular word reading and nonword reading (rIN=.80) was stronger overall than in most English-language studies, but significantly weaker, at $p/2<.05$, than rRI ($r=.86$) and rRN ($r=.86$). The pattern of correlations remained exactly the same when the ceiling scores (scores of the students who attained an average score of over 90%) were removed.

Insert table 2 about here

Analysis of reading profiles. Given the strong correlation between the two variables, the greatest proportion of the sample was constituted of readers whose

performance was either above the median for the two variables or below the median for the two variables (Figure 1). Nevertheless, we could identify two subgroups of subjects close to the medians with slightly different profiles : high N scores and low I scores, or high I scores and low N scores. To support this classification, a cluster analysis was conducted on all individual I and N data after scores had been standardized (z scores).

The method applied for producing clusters was Ward's algorithm on Euclidean distances (Ward, 1963). The purpose of this algorithm is to assign statistical individuals to clusters which are then iteratively joined together, using an analysis of variance to measure the distance between the clusters, in order to minimize the sum of the squares of any two clusters that can be formed at each step. Hierarchical trees of individual data represent the distances between individuals and joined clusters. We decided that a division into five groups (accounting for 83 % of total variance) was the most appropriate solution in the hierarchical tree on the basis of a trade-off between number of clusters (as low as possible) and within-cluster dispersion.

The distribution of the individual profiles into clusters is shown in Figure 1. The participants who performed well above average on both measures belonged to Cluster 1 (mean z=0.76 and 1.07 for N and I respectively). Cluster 2 contained the students who could be regarded as displaying a sub-lexical style of reading, as they were among the most efficient at applying GPC rules (mean z=0.72) and average or below average at using the orthographic process (mean z=0.0). Cluster 3 contained students who displayed the opposite pattern (relatively better on I scores, mean z=0.44, than on N scores, mean z=0.15) and could be regarded as lexical readers. Clusters 4 and 5 included those students who had the lowest scores

on both measures and were designated as poor and very poor readers respectively (mean z=-0.66 and -2.46 for N; mean z=-0.68 and -2.32 for I).

Mean reading scores for all five groups are shown in Table 3 (top). Scheffé post-hoc tests were used for statistically testing the group effects. On average, sub-lexical readers were as good as good readers at nonword reading ($p>.10$) but were poorer at irregular word reading ($p<.001$), whereas lexical readers were below good readers on both measures ($p<.001$) but better than sub-lexicals at irregular word reading ($p<.001$). Conversely, none of the three groups differed significantly on regular word reading ($p>.10$). Poor and very poor readers performed significantly worse on all word reading tasks ($p<.001$).

Insert figure 1 about here

Comparison between groups. In order to further validate the distinction between the sub-lexical and lexical groups, assumed to differ in styles of reading, we looked for differences between groups for the effects of regularity (related to reliance on phonological decoding) and of lexicality (related to the establishment of an orthographic lexicon). Two ANOVAs were conducted on the factors Group (2) x Regularity (2) x Frequency (2) x Length (2), and Group (2) x Lexicality (2) x Length (2) respectively.

The frequency effect was similarly significant for both groups ($F(1,72)=220.98$, $p<.00$, $d=1.749$; $F<1$ for the interaction). However, the regularity effect was greater for the sub-lexical group ($d=5.558$) than for the lexical one ($d=3.815$; $F(1,72)=36.23$, $p<.001$ for the interaction), while the lexicality effect

was far stronger for the lexical group (d=2.447) than for the sub-lexical one (d=0.685; F(1,72)=62.08, p<.001 for the interaction).

Insert table 3 about here

The following comparisons examined whether the reading profiles were associated with other linguistic deficits (Table 3). All the overall comparisons were significant, with good readers having better performances than lexical and sub-lexical ones, who had better scores than poor and very poor readers (p<. 001).

In spelling, lexical students obtained higher percentages of correct responses than sub-lexical students (51.0 *vs.* 47.1, d=0.301), but the effect was not significant (t(71)=-1.27, p>.10). In fact, the group effect was marginally significant only in reading comprehension (t(72)=-1.63, p/2<.06, d=0.384) and reading errors (t(72)=-1.47, p/2<.08, d=0.346), confirming that lexical readers adopt a more global approach to reading. There was no difference in the metaphonological test (t<1).

All things considered, five groups were identified in the cluster analysis, on the basis of N and I performance. Two of them presented a lexical and sub-lexical profile respectively, with contrasting performance on N and I. However, there was no important difference (although significant) between the so-called lexical and sub-lexical groups. Quantitative differences between higher performers and lower performers in reading seemed to account for most of the variation in the sample as a whole.

Analysis 3: Individual differences in the spelling of isolated words

Correlation and cluster analyses were carried out on individual spelling data in order to test whether lexical and sub-lexical profiles could be identified in spelling, with more contrasting performances than in reading on account of the asymmetry of French orthography.

Analysis of correlations. As expected, the coefficients of correlation between the spelling tasks rRI (.78) and rRN (.72) were lower than in reading (at p/2<.01) and more similar to results obtained in English (Treiman, 1984). Moreover, the correlation between irregular word spelling and nonword spelling (rIN=.59) was significantly lower than in reading (at p/2<.001) and significantly lower than the other two in spelling (rRI=.78 and rRN=.72; p/2<.001 and p/2<.025 respectively). This reflected a greater independence of phonological and orthographic processing in spelling than in reading.

Insert table 4 about here

Analysis of spelling profiles. The cluster analysis conducted on individual I and N standardized scores revealed that a division into 5 clusters was the most appropriate solution, providing interpretable groups that accounted for a high percentage of total variance (88.8%). Figure 2 shows the distribution of the individual profiles, while mean spelling scores per group are displayed in Table 5 (top). Scheffé post-hoc tests were used to statistically test the group effects.

Insert figure 2 about here

Clusters 1 and 2 contained the best performers on the two variables. They obtained similar high scores on nonword spelling (mean z=0.88 and 0.79) but differed on irregular word spelling (mean z=1.93 and 0.37). Scheffé post-hoc tests on the mean reading scores (Table 5) showed that the two groups differed significantly on irregular words (p<.001), as well as on regular words (p<.001), but not on nonwords (p>.10).Thus, Clusters 1 and 2 were interpreted as the groups of good spellers, with a delay in orthographic processing for Cluster 2.

Clusters 3 and 4 were intermediate groups that displayed opposite patterns, with average N scores and low I scores (Cluster 3, mean z=0.0 and -0.67) or low N scores and average I scores (Cluster 4, mean z=-0.84 and 0.13). These group effects were significant for N (p<.001) and I (p<.001), but the two groups did not differ significantly for regular words (p>.10). Consequently, the students in these clusters could be regarded as sub-lexical and lexical spellers respectively. Cluster 5 included those students who had the lowest scores on both measures and were designated as poor spellers (mean z=-1.55 and 1.09). They performed significantly worse than the other groups on all three spelling tasks (p<.001).

Insert table 5 about here

Comparison between groups. As in reading, the word effects were compared for sub-lexical and lexical spellers in an attempt to validate the distinction between spelling styles. The 2 x 2 x 2 x 2 ANOVA on real words revealed that the regularity effect was similarly significant for both groups ($F(1,53)=667.39$, $p<.001$, $d=3.562$; $F(1,53)=1.99$, $p>.10$ for the interaction). However, frequency had a stronger effect in the lexical group ($d=1.750$) than in the

sub-lexical one (d=1.196; F(1,53)=7.23, p<.01 for the interaction) proving that the former relied more on stored lexical knowledge than the latter. In addition, the 2 x 2 x 2 ANOVA on regular words and nonwords showed that lexicality had the opposite significant effect for both groups (F(1,53)=45.15, p<.001 for the interaction). While the sub-lexical spellers spelled nonwords slightly better than real words (d=-0.347; F(1,53)=4.44, p<.05), lexical spellers were far better at spelling real words (d=1.570; F(1,53)= 44.54, p<.001). This is also compatible with the idea that the former tend to use phonological rules to spell, whereas the latter have difficulty in transcribing phonological codes and rely more on lexical knowledge.

The following comparisons examined whether students with different spelling profiles were characterized by specific reading performances and phonological skills (Table 5). All the overall comparisons were significant, with the two groups of good spellers performing better than the lexical and sub-lexical ones, which, in turn, performed better than the poor spellers (p<. 001).

In reading, the lexical and sub-lexical spellers differed significantly only for the percentages of correctly read irregular words (t(53)=-2.57, p<.05, d=0.706), confirming that lexicals, as expected, display more accurate word-specific knowledge. Similarly, when it came to the other linguistic variables, the lexical spellers read faster and were slightly better at reading comprehension. These effects were marginally significant (t(53)=1.55, p/2<.07, d=0.426 and t(53)=1.35, p/2<.10, d=0.371). No differences were recorded in the metaphonological test (t<1).

The same comparisons conducted for the two different profiles that were unexpectedly emerging in the good spellers showed that students in Cluster 1 were

better than those in Cluster 2 in terms of irregular word reading ($t(71)=4.68$, $p<.001$ for I), reading speed ($t(71)=-3.84$, $p<.001$) and in-context reading errors ($t(71)=-2.78$, $p<.01$), as well as metaphonological abilities ($t(71)=2.57$, $p<.05$). This is compatible with the above-mentioned idea that the first group was more advanced in the acquisition of lexical knowledge – a fact which could be ascribed to more highly-developed metaphonological skills.

Correspondence between reader profiles and speller profiles.

The correspondences between reading and spelling (Table 6) showed a significant relationship between the two tasks ($X^2(16, N = 157) = 124.83$, $p < .001$), with most of the good/poor readers being good/poor spellers. However, the distribution of sub-lexical readers and lexical readers across spelling styles did not differ significantly ($X^2(4, N = 73) = 7.04$, $p > .10$). In these two average groups, most of the students had specific major difficulties with orthographic codes in spelling, as if orthographic development in spelling depended on the acquisition of both phonological and lexical knowledge in reading.

insert table 6 about here

Discussion

The main goal of the study was to explore whether it is possible to identify lexical and sub-lexical readers and spellers among French 2nd-graders by comparing how they read and spell regular words, irregular words, and nonwords.

As far as reading is concerned, the very high correlation between nonword and irregular word reading demonstrated that the students who were the most efficient at applying GPC rules were also better at using orthographic knowledge.

Nevertheless, a cluster analysis on standardized N and I scores revealed the existence of five different groups. Three groups were identified as good, poor and very poor readers respectively. In the other two, although the students were as competent as good readers at regular word reading, they had slightly different profiles on the other variables. In one group (referred to as the lexical group), they were good at irregular word reading but average or below the average on nonword reading, producing many substitutions. In the other group (the sub-lexical one), they were good at nonword reading but poorer on irregular words, producing many more regularizations.

In order to validate the hypothesis that the two groups differed in their dominant reliance on either phonological decoding or orthographic processing, we conducted an analysis of the regularity and lexicality effects. The fact that these effects were significant for both groups can be interpreted as evidence of the construction of orthographic representations, with simultaneous recourse to phonological decoding in both groups. However, significant interactions in the expected way showed that the reading performance of the lexical group was less affected by word irregularity than that of the sub-lexical one, but deteriorated more when the items were nonwords rather than words. This confirmed that the students in each group preferentially relied on one *or* the other process. Two measurements in other independent tasks also highlighted differences between the two groups: the lexical group was better at text comprehension and made more errors on text reading for the same reading time. These effects were moderate but significant and compatible with the hypothesis that lexicals tended to adopt a more global approach in reading. Conversely, there was no difference between the groups in

either the metaphonological tasks or word spelling. This point will be discussed later.

In spelling, as expected, the coefficients of correlation were generally lower than in reading. Moreover, the correlation between irregular word spelling and nonword spelling was significantly lower than between the other two. The cluster analysis on standardized N and I scores revealed the existence of five profiles. Two groups of good spellers scored better than the rest of the sample, but differed between each other on irregular word spelling. Apparently, these students had reached the same level when it came to applying PGC rules and transcribing words, but some had more orthographic knowledge available, with the result that they spelled irregular words, and to some extent regular words that might contain non-univocal PG correspondences, with fewer errors. They were also faster and more accurate at reading a text and could read more irregular words. They obtained the highest scores on metaphonological tests, which suggests that phonological awareness is not only related to the acquisition of conversion rules but also to orthographic development.

Two other groups, with lower overall performances, contrasted on both variables. The students in one group had far more difficulty spelling irregular words, but were far more efficient at spelling nonwords than the ones in the other group. The former were designated sub-lexical spellers, relying more on the words' phonological codes and PGC rules, which explained the large number of errors on the spelling of irregular words (regularization errors) and regular words (omission of silent letters). The latter, referred to as lexical spellers, relied more on orthographic knowledge to spell the words, having difficulty in transcribing phonological codes. The comparisons of word category effects in both groups

supported this classification. Although the regularity effect was present in both groups (irregular words being more complex to spell whatever the process), the frequency effect was stronger in the lexical group than in the sub-lexical one. And above all, students in this group were more accurate at spelling words than nonwords, whereas students in the sub-lexical group were better at spelling nonwords than words. This is compatible with the idea that the former preferentially used stored lexical knowledge for spelling whereas the latter were better at using PGC rules than orthographic ones.

The last group contained the poor spellers, who had the lowest scores on spelling tasks and indeed the poorest performances on all measures. For reading as for spelling, it should be noted that the groups were made up of subjects from different classes and schools, which proves that there was no link between possible idiosyncrasies in teaching methods and differences in the subjects' profiles or levels.

All things considered, qualitative individual differences appeared in both reading *and* spelling on a continuum between sub-lexical and lexical styles of the processing of words. However as expected, the emergence of distinct profiles at a qualitative level was more convincing in spelling. For a start, correlations between irregular word and nonword lists were lower in spelling (rIN = .59 *vs.* rIN = .80), reflecting a greater independence of phonological and orthographic processes in spelling than in reading. Second, the profiles were more diversified: for instance, in addition to the sub-lexical and lexical groups, two groups of good spellers appeared in the cluster analysis, differing on the orthographic knowledge level. The spelling profiles also contrasted more (e.g. *z* score differences between lexicals and sub-lexicals on one hand, and lexicals, sub-lexicals and better spellers

on the other). Lastly, the strongest group x lexicality interaction was observed in spelling, where lexicality had opposite effects for the lexical and sub-lexical groups. Consequently, we might conclude that, in reading, most of the variation was accounted for by quantitative differences between higher performers and lower performers, whereas in spelling more various styles could be discerned.

As a corollary, our results were quite different from results obtained in English, at least for reading. Correlations in reading were significantly stronger than in most of the English-language studies. Reading profiles offered less of a contrast than in the studies conducted by Freebody and Byrne (1988) and Castles et al. (1997), with the mean *z* score distances between lexical and sub-lexical groups for I and N being twice as high in these studies as in our study. Not all expected differences were found, especially in reading times, which should have been shorter in lexicals, as Freebody and Byrne found. Like us, these authors failed to detect any significant differences in phonemic awareness in favor of the sub-lexical group, although both groups performed worse than the good readers and better than the poor ones on metaphonological tests. As they have suggested, this is compatible with the notion that phonological awareness is necessary but not sufficient for the development of phonological decoding.

These results were expected, given the differences between the French and English orthographic systems: unlike English, French is relatively transparent in the direction of spelling-to-sound, but as complex as English in the direction of sound-to-spelling (Ziegler et al., 1996). One explanation of the divergent results in French and in English is that more consistent GPC rules could account for less variability in reading among French-speaking students than among English-speaking ones. On the other hand, the inconsistencies of written French could

explain the greater heterogeneity in the styles of spelling acquisition. The correlations between the spelling tasks in our study were of the same magnitude as those reported in English studies. Nothing can be said about the similarity between profiles in both languages, for until now, no study has looked for individual profiles showing opposite patterns of reliance on the two processes in spelling. The evidence presented for the existence of various styles had been somewhat indirect, based on correlation analysis or comparisons between spelling errors of different styles of readers (Treiman, 1984; Castles et al., 1997).

How can the distinctive characteristics of the languages explain the divergence between our findings and those of previous studies? The consistency of French orthography in the direction of spelling-to-sound probably makes it necessary - and to some extent sufficient - to master the GPC rules in order to be able to read words. Phonological decoding in French is so efficient, at least in the early stages of acquisition, that it may be given priority in development; whereas in English, a far deeper language, the orthographic system has to be put in place from the very outset, so that the very many irregular words can be read. As the lexical procedure is not as necessary in French, we may assume that it uses up fewer "learning resources". It is as if, in English, subjects ran a greater risk of performing less well in one or other of its components because the task is more difficult (as proven by comparisons of error rates in inter-language studies; Goswami et al., 1998). The same reasoning could explain the results in spelling on the basis of the inconsistencies of French orthography in the direction of sound-to-spelling.

Our results broadly lend weight to the idea that phonological abilities are a determining factor in reading acquisition (Perfetti, 1992; Share, 1995).

Phonological decoding must come up to a minimal threshold for words to be correctly decoded. If it does not, as is the case of poor readers, all reading tasks are affected. If it does, albeit partially, as is the case of lexical readers, reading and writing develop quite well. No case of good phonological skills associated with low orthographic skills was observed in reading. Sub-lexical and lexical readers seemed to differ in terms of word identification processing reliance, but both achieved average performances for all the reading variables. These findings can be set alongside those of French-language studies of dyslexia (Sprenger-Charolles et al., 2000; Valdois, 2000), which have failed to find any pure double dissociation between phonological and orthographic mechanisms. They do not, therefore, support the hypothesis of the two processes being functionally independent.

Our findings are, however, compatible with a developmental model in which the two word identification processes are constructed not one after the other but in interaction. This type of model postulates that the phonological strategy allows the development of the lexical process and, in return, benefits from the implementation of this process, which enriches both alphabetic and orthographic knowledge. Here, the interaction is reflected in the strong correlation between the reading of nonwords and irregular words, and, in the case of some readers, in the delayed development of phonological or orthographic procedures, with both types of delay being related to lower metaphonological abilities. The data recently collected by Aaron et al. (1999) also support this view.

The double-foundation model elaborated by Seymour (1990, 1997) allows us to account for some heterogeneity of reading styles, however, regarding the relative interdependence of phonological and orthographic development. According to Seymour, the strategies postulated in stage models do not correspond

to consecutive phases but, instead, co-exist from the very start of the acquisition process. Thus, the orthographic lexicon is built on the basis of both logographic and alphabetic processes. The former allows for the construction of a lexicon of whole words, while the latter is gradually established with the development of metaphonological abilities. According to the development level of each process and the nature of its eventual deficit (logographic, alphabetic or both), the specific characteristics of the orthographic lexicon may vary from one reader to another, hence a certain heterogeneity in reading acquisition, with relatively more or less ability to memorize word-specific associations and use conversion rules.

With regard to the relationship between reading and spelling, our results support the idea that spelling is more difficult and does not rely on exactly the same representations or mechanisms as reading (Bosman & Van Orden, 1997). Performances on word spelling (46% of correct responses) were greatly inferior to those obtained on word reading (73%), and no correspondence could be established between reading and spelling styles. In fact, it was the general level of reading acquisition that was related to spelling. Good and average readers - lexicals and sub-lexicals – were mostly classified as good spellers (sometimes with an orthographic delay), poor readers as lexical or sub-lexical spellers, and very poor readers as the poorest spellers. This allows to make two remarks. First, the conception developed by Frith (1985), according to which students move from alphabetic strategies to orthographic ones first for reading, then for spelling, was attested here. Many good readers presented an orthographic delay in spelling, whereas almost every good speller was also a good reader, suggesting that orthographic development in spelling depends on the mastery of both phonological and lexical processes in reading. Second, lexical and sub-lexical readers had the

same spelling profiles, especially for nonword spelling, meaning that despite their dominant reliance on conversion rules or word specific knowledge respectively for reading, they were equal in their ability to use phonological codes for spelling nonwords. This is another discrepancy with results in English (Castles et al., 1997).

The observation of qualitative differences in spelling that are different from those in reading (more diversified and distant profiles) suggests differences in the processes by which these two activities are acquired and the ways in which these acquisition processes can be impaired. The fact that phoneme-grapheme correspondences are far less consistent than grapheme-phoneme correspondences means that spelling has a greater reliance on the lexical process, the efficiency of which is thus an additional source of individual differences. In addition, a regularization error due to the application of grapheme-phoneme rules in reading is more likely to be perceived as an error by children, on the basis of the recognition of meaning, than a regularization error due to the application of phoneme-grapheme rules in spelling. As a result, spelling requires specific strategies to strengthen relationships between graphemes and word meanings.

In conclusion, further investigation of lexical and sub-lexical styles might provide information about the development and use of reading and spelling strategies. The finding that distinct styles can be distinguished in the early stages of the acquisition of written language raises the question of whether different types of readers and spellers also differ in their later acquisitions of literacy. This seems to us particularly relevant for spelling, a more complex activity which causes difficulties for many young students, with these difficulties having different sources. Given that both lexical and sub-lexical skills are related to being an

efficient speller, and that spelling problems persist well beyong the first years of learning, even for pupils within the normal range of reading ability, teachers should take into account the reliance profile of individual children at the beginning of the learning process and provide appropriate instruction in those skills which may be less developed.

APPENDIX 1 – Excerpts from lists of items for the isolated word reading and spelling tasks.

	Frequent irregular words	Frequent regular words	Nonwords
Short items			
	dix (ten)	mer (sea)	bir
	sept (seven)	bête (animal)	nède
	pied (foot)	ciel (sky)	rial
	août (August)	soir (evening)	doil
	femme (woman)	frère (brother)	trire
Long items			
	second (second)	jardin (garden)	castin
	monsieur (mister)	histoire (story)	virtoise
	automne (autumn)	docteur (doctor)	porbeul
	compter (to count)	prendre (to take)	grindre
	paysan (farmer)	poésie (poem)	loédie
	Rare irregular words	**Rare regular words**	**Nonwords**
Short items			
	clown (clown)	farce (joke)	macre
	thym (thyme)	mare (pond)	nire
	poêle (stove)	tuile (tile)	buime
	faon (fawn)	fixe (fixed)	fage
	scier (to saw)	louer (to rent)	mugue
Long items			
	alcool (alcohol)	salade (salad)	tamare
	sixième (sixth)	vitrine (window)	pitrone
	oignon (onion)	jambon (ham)	jaudon
	vingtaine (about twenty)	chaussure (shoe)	chintière
	chorale (choral)	copieur (cribber)	craleur

APPENDIX 2 - Extract from the comprehension test.

Lis attentivement cette histoire:

Michèle et Caroline sont confiées par leur mère, pour la durée des vacances, à Madame Parris qui dirige une ferme en Vendée. Caroline part tous les matins avec Laurent, le petit vacher, conduire les bêtes au grand pâturage, tandis que sa sœur pèse dans de petits paniers, les groseilles et les framboises que la servante a cueillies dans le verger de la ferme.

(**Read this story carefully :**

During the vacation, Michèle and Caroline's mother left them in the care of Madame Parris, who ran a farm in Vendée. Each morning, Caroline set off with Laurent, the young cowherd, to take the cattle to the big pasture, while her sister weighed out tiny baskets of redcurrants and raspberries which the servant picked in the farm's orchard.)

Complète les réponses aux questions:

1. Qui s'occupe des fillettes pendant les vacances ? **c'est** .....
2. Où passent-elles les vacances? **elles passent les vacances dans** .....
3. Qui est Laurent ? **Laurent est** .....
4. Qui conduit les bêtes au pâturage? **c'est** .....
5. Qui cueille les fruits? **c'est** .....
6. Que fait Michèle le matin? **Michèle** .....

(**Complete the answers to the questions :**

1. Who looked after the little girls during the vacation ? **It was** .....
2. Where did they spend their vacation ? **They spent their vacation in** .....
3. Who was Laurent ? **Laurent was** .....
4. Who took the cattle to the pasture ? **It was** .....
5. Who picked the fruit ? **It was** .....
6. What did Michèle do in the morning ? **Michèle** .....)

APPENDIX 3 - “Jeannot et Georges” Test (Hermabessière & Sax, 1972).

Text 1 "Jeannot"

Jeannot emporte dans son sac les plus beaux fruits de la saison : une poire juteuse à plaisir, quelques prunes fraîches et mauves ; un croûton de pain et deux ou trois morceaux de sucre formeront son repas. Il va à la pêche et déjà il voit les jolis poissons argentés, moirés, gris ou roses, tâchés, luisants.

Il décroche la barque qui, bientôt, trouble les flots d'un sillage lent. Le village disparaît après quelques coups de rame.

(Jeannot set off, his bag filled with the finest fruit the season had to offer - a deliciously juicy pear and a handful of fresh, purple plums. A crust of bread and a couple of sugar lumps completed his meal. He was going fishing and could already see in his mind’s eye the gleam of the pretty fish - silvery, speckled, shimmering, pink or gray.

He untied the boat, and its slow wake soon sent gentle ripples through the water. A few strokes of the oars and the village disappeared from view.)

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Table 1: Mean percentages of correct responses for the reading task and spelling task as a function of word category

	Regular word reading		Irregular word reading		Nonword reading
	Frequent	Rare	Frequent	Rare	
Reading					
Short words	90.6	83.6	68.5	41.8	77.6
Long words	90.6	84.0	67.7	57.5	70.6
Spelling					
Short words	64.1	53.9	54.1	9.4	64.9
Long words	59.6	56.9	15.6	12.9	50.2

Table 2: Coefficients of correlation between regular word reading (R), irregular word reading (I) and nonword reading (N)

	Our 2nd grade sample	Baron, 1979	Castles et al., 1997	Freebody & Byrne, 1988	Gough & Walsh, 1991	Treiman, 1984
rR,I	.86	.65	.72	.60	.80	.75
rR,N	.86	.84	.84	.62	.76	.81
rI,N	.80	.42	.71	.57	.66	.55

Table 3: Mean performances of groups across reading tasks and other linguistic variables

	CLUSTER 1 Good Readers (n= 35)	CLUSTER 2 Sub-lexical readers (n= 33)	CLUSTER 3 Lexical readers (n= 41)	CLUSTER 4 Poor Readers (n= 37)	CLUSTER 5 Very Poor Readers (n= 13)
Regular word reading	39.1	37.4	37.2	32.4	16.8
Irregular word reading	31.9	23.5	27.0	18.3	05.4
Nonword reading	36.1	35.7	30.9	24.0	08.8
Regular word spelling	30.4	24.1	24.8	18.5	10.2
Irregular word spelling	15.7	08.4	09.4	05.6	02.6
Nonword spelling	30.2	24.4	27.0	16.2	07.8
Metaphonology (/24)	17.9	14.1	14.6	08.8	04.0
RT (sec.) / Jeannot	66.3	92.5	91.2	145.6	246.5
Errors / Jeannot	01.8	02.7	03.6	08.3	27.8
Comprehension(/48)	23.1	18.8	21.6	12.1	05.6

Table 4: Coefficients of correlation between regular word spelling (R), irregular word spelling (I) and nonword spelling (N)

	Our 2nd grade sample	Castles et al., 1997	Treiman, 1984
rR.I	.78	.72	.75
rR.N	.72	.66	.81
rI.N	.59	.44	.55

Table 5: Mean performances of spelling groups across spelling tasks and other linguistic variables

	CLUSTER 1 Good spellers (n= 18)	CLUSTER 2 Good spellers with ortho. delay (n= 55)	CLUSTER 3 Sub-lexical spellers (n= 38)	CLUSTER 4 Lexical spellers (n= 17)	CLUSTER 5 Poor spellers (n= 29)
Regular word spelling	32.3	27.8	20.9	23.1	12.3
Irregular word spelling	19.7	11.2	05.6	09.9	03.3
Nonword spelling	32.3	31.4	23.2	14.4	06.9
Regular word reading	39.1	38.0	34.5	35.9	27.0
Irregular word reading	31.7	27.4	21.0	25.2	14.0
Nonword reading	36.4	34.0	28.4	27.5	20.7
Metaphonology (/24)	19.3	16.5	10.8	10.2	07.1
RT (sec.) / Jeannot	56.0	81.9	116.2	97.1	204.3
Errors / Jeannot	01.3	02.6	05.5	05.6	15.0
Comprehension(/48)	25.1	22.8	14.7	17.4	08.4

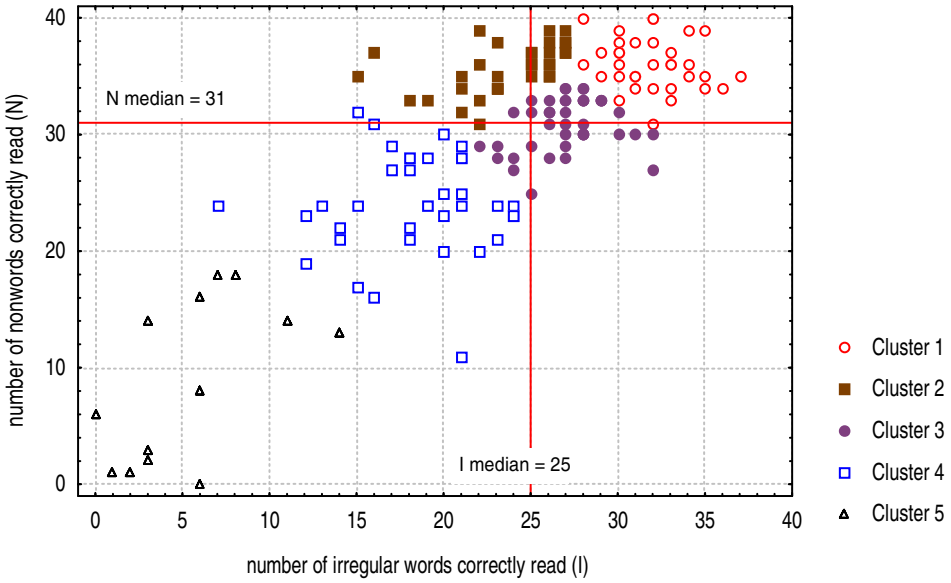
Table 6: Numbers of subjects per group in reading and spelling

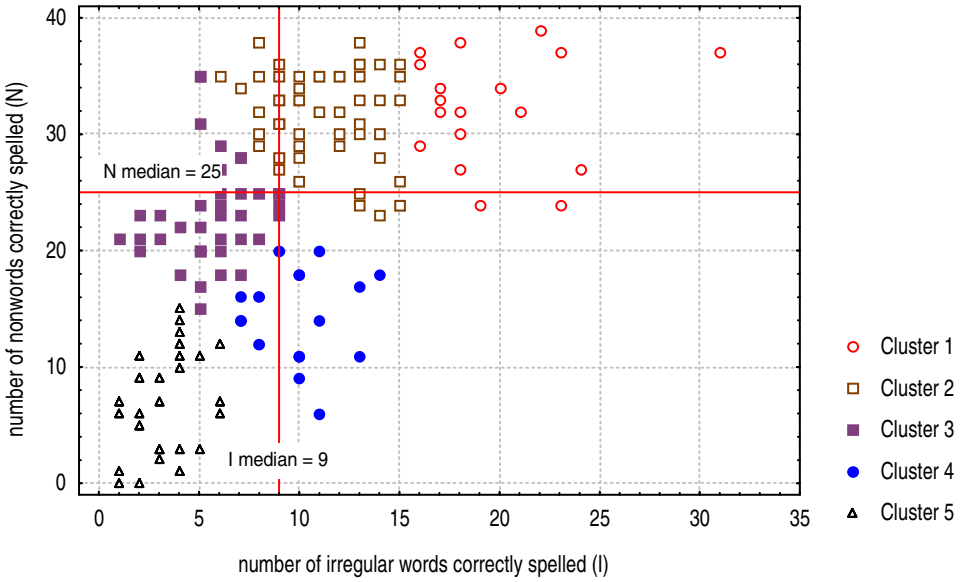
	Good spellers	Good spellers with orthog. delay	Sub-lexical spellers	Lexical spellers	Poor spellers
Good readers	**15**	**16**	1	3	0
Sub-lexical readers	3	**13**	8	3	5
Lexical readers	0	**23**	**11**	5	2
Poor readers	0	3	**17**	6	11
Very poor readers	0	0	1	0	**11**

Figure captions

Figure 1: Diagram of correlation between irregular word reading and nonword reading and distribution of individual profiles into clusters (median number of correct responses is indicated for each list)

Figure 2: Diagram of correlation between irregular word spelling and nonword spelling and distribution of individual profiles into clusters (median number of correct responses is indicated for each list)


N median = 31
I median = 25
number of nonwords correctly read (N)
number of irregular words correctly read (I)
0
10
20
30
40
0
5
10
15
20
25
30
35
40
Cluster 1
Cluster 2
Cluster 3
Cluster 4
Cluster 5


number of nonwords correctly spelled (N)
number of irregular words correctly spelled (I)
N median = 25
I median = 9
0
10
20
30
40
0
5
10
15
20
25
30
35
Cluster 1
Cluster 2
Cluster 3
Cluster 4
Cluster 5

Footnote

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